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TITLE: APPARATUS AND METHOD FOR HARNESSING OPTICAL FIBER TO A CIRCUIT BOARD

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APPARATUS AND METHOD FOR HARNESSING OPTICAL FIBER TO A CIRCUIT BOARD

FIELD OF THE INVENTION

This invention relates generally to the field of mechanical fasteners for printed circuit board applications and, in particular, to a means and method for harnessing or retaining optical fiber to a printed circuit board or the like.

BACKGROUND OF THE INVENTION

It is conventional to process or route information to and from many types of electronic devices via fiber optic cables, especially when large amounts of data or large numbers of signals need to be transmitted. Typically, the electronic devices include printed circuit boards with various components used to process the signals or perform needed operations. The components may include typical electronic and opto-electronic devices such as transceivers and so on. Typically, one end of a fiber optic cable is fastened to the circuit board by a connector that allows communication with an incoming or external fiber optic cable. A length of fiber optic cable may then extend from the connector to a device attached to the circuit board and thus permit data transmission therebetween.

However, fiber optic cable has physical limitations, notably the bending it can withstand without failure. The limitation on the bending that a fiber optic cable can withstand prior to failure is known as the minimum bend radius. Due to this physical limitation, devices have been created to manage or harness fiber optic cable to a printed circuit board in such a manner as to prevent over bending of the fiber optic cable and to prevent entanglement of the cable with adjacent components or boards, especially during installation of the board. One such harnessing or retaining device is a retaining eye loop. This prior art device resembles a ring mounted upon a post. The post

includes an arrow-shaped connector or head portion opposite the ring, which, when inserted through an opening in a circuit board, expands on the far side of the board and holds the retaining device in place. Examples of such snap leg latches are shown in figures 1 and 2 of Des. Patent No. 278,143 (see also, United States Patent Nos. 5,281,149, 5,255,159, and 6,058,579).

However, a disadvantage of such a retaining device is the difficulty of insertion of the connector portion, which can damage or break the circuit board. Further, the extent to which the retaining device extends outwardly from the circuit board, front and back, when installed, can increase the effective thickness of the circuit board, interfere with installation and damage adjacent components.

Accordingly, it would be desirable to provide an apparatus and method of providing improved retension of fiber optic cable to a circuit board, or the like, which overcomes the disadvantages described above.

SUMMARY OF THE INVENTION

One aspect of the present invention provides a clip apparatus for providing retension of fiber optic cable to a circuit board. The clip for retaining a length of fiber optic cable to a circuit board includes a body portion. The body portion of the apparatus includes at least a pair of spaced legs extending from the body portion, each of the legs is adapted to be received in a mounting opening formed in the PC board. Each of the spaced legs includes a foot portion adapted for securing the body to the circuit board and at least a pair of spaced arms extend from the body portion defining a slot between the arm and the body portion for receiving and retaining a portion of the length of fiber optic cable. The arms are spaced a distance from each other for retaining the fiber optic cable in an arc having a radius greater than a minimum bend radius of the fiber optic cable.

Another aspect of the invention provides a PC board and retaining clip assembly for retaining a length of fiber optic cable thereto, including a PC board including two pair of mounting openings. A pair of retaining clips are attached to the PC board. Each of the clips includes a body portion with a

pair of spaced legs inserted into the pair of mounting openings. Each of the clips includes a pair of spaced arms. Each of the arms defines a slot with the body portion and a length of optic cable is retained in the slots of the pair of retaining clips.

Anther aspect of the invention provides a method of operation of a retention clip adapted to be mounted directly to a PC board for retaining a length of fiber optic cable on the PC board, including providing a first and second pair of openings through the PC board in a spaced apart configuration. Pressure is applied to a first pair of legs on a first retention clip such that the first pair of legs may be inserted through the first pair of openings on the PC board. Pressure is released from the first pair of legs to retain the first clip to the PC board. Pressure is applied to a second pair of legs on a second retention clip such that the second pair of legs may be inserted through the second pair of openings on the PC board and retained thereto. Pressure is released from the second pair of legs to retain the second clip to the PC board and the length of fiber optic cable is secured to the first and second retention clips in a radius greater than a minimum bend radius of the fiber optic cable.

In yet another aspect of the method of the present invention the securing the length of fiber optic cable may include providing a first pair of slots to the first retention clip, providing a second pair of slots to the second retention clip, inserting a first portion of the length of the fiber optic cable into the first pair of slots, inserting a second portion of the length of the fiber optic cable into the second pair of slots and closing the first and second pair of slots.

Another aspect of the present invention provides a clip including a body portion. The body portion includes a pair of spaced first and second legs extending in a first direction from the body portion and a pair of spaced arms extending in a second direction from the body portion. The second direction is opposite from the first direction. The arms define a slot with the body portion. The arms may further include means for locking a distal end of

each the arms to the body portion.

The invention provides the foregoing and other features, and the advantages of the invention will become further apparent from the following detailed description of the presently preferred embodiments, read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the invention and do not limit the scope of the invention, which is defined by the appended claims and equivalents thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of one embodiment of a clip that is made in accordance with the invention for retaining fiber optic cable to a PC board;

FIG. 2 is a top view of the clip of FIG. 1;

FIG. 3 is a side view of the clip of FIG. 1 installed on a PC board;

FIG. 4 is a side view of the clip of FIG.;

FIG. 5 is an end view of the clip of FIG. 1 with the arms engaged with the body portion;

FIG. 6 is a perspective view of another embodiment of a clip according to the present invention;

FIG. 7 is a perspective view of a pair of clips according to one embodiment of the present invention retaining a length of fiber optic cable; and

FIG. 8 is another embodiment of a clip of the present invention.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

As shown in **FIGS. 1-5**, one embodiment of an apparatus for holding fiber optic cable to a printed circuit (PC) board, or the like is illustrated generally at **10**. The apparatus **10**, which may be a clip, harness, spring assembly, retainer or the like, may include a body portion generally indicated at **12**. In general, formed from or attached to the body portion **12** may be a pair of spaced legs **14**, **16** for holding the apparatus **10** to a PC board and a

pair of arms **22**, **24** for retaining a length of fiber optic cable.

The clip body portion **12** can be constructed of a spring steel material by stamping, punching or any suitable method. It will be understood that the clip may be formed of any suitable resilient material such as, for example, metal or plastic, which may tend to spring back into shape after being bent or biased. The clip may be formed from a single strip or blank of material. In the alternate, the clip may be formed from more than a single piece of material.

In the embodiment shown, the clip apparatus **10** may be formed from a single blank or strip of material. In such a case, the legs **14**, **16** and arms **22**, **24** and other elements of the apparatus are defined by separating the elements from the strip of material in one or more pressing, stamping or other suitable operation. In the case of arms **22**, **24** being separated from the body **12**, slots or openings **26**, **28** may be left in the body **12**. Of course, other methods may be used to form the body **12**, legs **14**, **16** and arms **22**, **24** of clip apparatus **10**, such as, for example, welding, gluing, thermoforming, molding and so on.

The body portion **12** may include a pair of legs **14**, **16**, formed at an angle from the body **12**. Each leg may include one, two or more spans of material (for example, a pair of spans shown at **16A**, **16B**) attached to the body portion. The legs **14**, **16** may be bent into position or otherwise formed at an angle from the body **12**.

Each leg **14**, **16** may include a respective foot **18**, **20** formed at an angle from the legs. The feet **18**, **20** may have a tab, flange, or lip shape or flattened extensions of the leg or the like. In the illustrated embodiment, the feet **18**, **20** are formed essentially parallel to the axis of the body by bending or any suitable method. In this manner, as will be explained more fully herein, the legs **14**, **16** and feet **18**, **20** can hold the clip **10** to a PC board (not shown) when installed.

A pair of arms **22**, **24** extend from the body portion **12**. The arms **22**, **24**, as shown in the illustrated embodiment, may extend from an attached

position adjacent the outer edges of the body portion **12** or the legs **14**, **16**. In the alternate, the arms may extend (not shown) from a central portion **30** of the body **12** as long as the spacing is such that the minimum radius of the cable (see **FIG. 7**) is maintained. Further, it is contemplated that the arms **22**, **24** may be spaced apart from the body portion **12** in a direction above or below the body **12**. In other words, while the embodiment illustrated shows the arms **22**, **24** spaced or extending from the body **12** in an opposite direction from that of the legs **14**, **16**, i.e., "over" the body, the arms **22**, **24** might be positioned or formed "under" the body as well. The notch, channel or space **32**, **34** between the body **12** and each respective arm serves to hold the fiber optic cable in position, for example, in a coiled configuration (see **FIG. 7**).

The free ends of each arm **22**, **24** may include a tab feature or widened end **36**, **38**, which when inserted into slots **26**, **28** of body **12**, catches with the adjacent body portion and forms a closed feature of the clip **10**. In this manner, a length or coil of cable can be securely held to the clip. It will be understood that the tab end **36**, **38** when separated from body **12** during manufacture will be approximately the transverse width of the opening **26**, **28** from which they were formed. When securing the tab portions **36**, **38** of the arms **22**, **24** to body **12** the tabs may be pressed through the openings at a wide point (from which the tabs originated). The tabs **36**, **38** will tend to spring back slightly and become fastened under the body **12** adjacent a narrower portion of the opening and thus preventing opening of the slots or notches **32**, **34**.

The clip **10** may be mounted on a circuit board such as the circuit board **50** shown in **FIG. 3**. Those of ordinary skill in the art will appreciate that the size, shape and configuration of the clip may vary depending upon the particular application. In addition, the clip as illustrated may preferably be used in pairs, for example, and further, may be used in a parallel configuration to secure a coil of cable at a plurality (e.g., four) of spaced points about the coil. The pair of clips may be formed as a single unit (not

shown) to provide the same or substantially the same benefits of the pair of clips. It will be understood that a coil may preferably be supported at a number of points spaced substantially equally apart. However, other arrangements or configurations are contemplated dependent upon the particular application.

Referring to **FIG. 3**, the circuit board **50** may preferably be a planar member and may preferably include an upper or first side **52**, a lower or back side **54**, and a plurality of mounting openings **56**, **58** formed therein. The circuit board **50** may preferably be any conventional printed circuit board. The leg portions **14**, **16** extend through the openings **56**, **58**. The feet **18**, **20** may be positioned against the back side **54** of the board **50** and may be held in position by the spring bias of the legs **14**, **16**. The feet **18**, **20** can function to prevent the clip **10** from becoming easily detached from the board **50**.

Referring to **FIG. 5**, the clip **10** is shown with the tabs **36**, **38** of the arms **22**, **24** engaged with the body **12** to close openings or slots **32**, **34**.

As shown in **FIG. 1**, legs **14**, **16** may extend outward angled to a position substantially perpendicular from the body **12**. The legs **14**, **16** are installed into suitable mounting holes in a PC board by hand or machine by first squeezing together, as shown in **FIG. 3** and inserting the legs into the mounting holes. Release of the legs **14**, **16** permits the legs to spring or flex outwardly and secure the clip to the PC board **50** as shown in **FIG. 4**, by contacting the edges of the board opening. Insertion of the legs **14**, **16** through the holes causes insertion of the feet **18**, **20** into a position extending below the PC board surface. An upper surface of the feet **18**, **20** is positioned co-planar with the underside of the PC board. Releasing the legs **14**, **16** causes the feet to come into contact with the underside of the PC board **50** and prevent the clip from becoming detached and removed therefrom.

As shown in **FIG. 7**, a coil of cable may be inserted into the notches **32**, **34**. When the tabs are captured or pressed into engagement with the sides of the openings **26**, **28** the cable is held in place to the clip or clips (see **FIG. 7**).

Referring to **FIG. 6**, another embodiment of the present invention is illustrated. The elements of the embodiment shown in **FIGS. 1-5** that are the same as the elements in the embodiment shown in **FIGS. 6-7** are identified with the same reference characters. Clip **10** includes body **12**, which may include two thicknesses or layers of material. Thus, in one embodiment, a second strip or additional layer of material may be affixed to the clip body **12** to effectively narrow the openings **26**, **28**. In this manner, the tab portions **36**, **38** are retained in a narrowed portion **60**, **62** of openings **26**, **28** when the tabs are depressed into the body (into a position similar to that shown in **FIG. 5**), thereby closing notches **32**, **34**. In operation, the tab portions **36**, **38** are inserted through the openings **26**, **28** of the body **12** and will tend to catch the underside of the body at the narrow portions **60**, **62**, thus preventing opening of the slots **32**, **34**.

Referring to **FIG. 7**, a coil of fiber optic cable **70** is shown held by a pair of clips **10A**, **10B**. The clips may be arranged in a substantially parallel configuration and together cooperate to prevent the coil from being tangled, bent or otherwise forced into a smaller than minimum bend radius.

Referring to **FIG. 8**, another embodiment of the present invention is illustrated. A clip, generally shown at **100**, includes clip body **112**. The body may have extending therefrom or attached thereto at an angle a pair of legs **114**, **116**. In one embodiment, a pair of arms **122**, **124** may extend from the clip body **112** on a side of the body generally opposite from that of the legs. Between the arms **122**, **124** and the body **112** slots or notches **132**, **134** are defined. Adjacent a terminal portion of the arms **122**, **124** a constricting feature **164**, **166** may be formed in each arm to constrict or close the notches **132**, **134**. In use, the arms **122**, **124** are spread apart from the body **112** or opened to permit insertion of a length or coil of cable into the notches **132**, **134**. Release of the arms **122**, **124** cause the constricting features **164**, **166** to close or obstruct the mouth of the notches and thus function to prevent release of the cable therefrom. As in the above embodiments, the clip **100** may be used in pairs to hold the coil of cable (not shown) at four points.

While the embodiments of the invention disclosed herein are presently considered to be preferred, various changes and modifications can be made without departing from the spirit and scope of the invention. The scope of the invention is indicated in the appended claims, and all changes that come within the meaning and range of equivalents are intended to be embraced therein.